NESDI Program Launches Eleven Technology Initiatives

Notable Efforts Target Water Conservation Challenges & Enhanced Stormwater Monitoring

THE NAVY ENVIRONMENTAL Sustainability Development to Integration (NESDI) program launched 11 new initiatives in 2015 to address some of the most pressing environmental operational challenges facing the Navy. These projects range from efforts to better understand the potential impacts of water conservation measures on installation drinking water infrastructure, address the safe disposal and remediation of munitions constituents, and improve the efficiency and effectiveness of stormwater monitoring systems.

Each year, the NESDI program collects environmental needs from across the Navy's shore community. Based on selected needs, project teams are formed to demonstrate, validate, and integrate innovative technologies, processes, and materials into fleet operations. In fiscal year 2015, after a total of 53 needs were collected, and 23 proposals were received and reviewed, the program gave the green light to the following 11 projects.

Project 524: Innovative Hydrant Flushing

Navy and Marine Corps installations worldwide are required to maintain a disinfectant residual in their drinking water systems. The chlorine or chloramine residual prevents bacteriological growth in the drinking water and is required under the Safe Drinking Water Act (SDWA) and associated Chief of Naval Operations Energy and Environmental Readiness Division instructions. However, this chlorine residue tends to be "consumed" by a buildup of biofilms and sediment in most water systems. Additionally, nitrification or trihalomethanes (THM) may also build up in the water distribution system. (Nitrification increases nitrite and nitrate levels, and promotes bacterial regrowth.)

To maintain compliance, Naval bases flush hydrants with millions of gallons of potable water to eradicate stagnant water, clean the pipes, increase the disinfection residual in the pipes, and flush out the nitrates and THMs.

> The flushing process wastes a tremendous amount of water—over a million gallons of water per year for one hydrant.

The flushing process can require a tremendous amount of water—over a million gallons of water per year for one hydrant. Not only is this expenditure of potable water wasteful in a severe and ongoing drought, but at some bases, the effective scouring velocity cannot be achieved by traditional hydrant flushing, even when done weekly. This means that nitrification can continue to occur despite the

The NO-DES truck.
Low Impact Development Center

massive outlay of water. This NESDI project was formed to find a solution to both problems.

The project team, headed by Tami Relph of the Naval Facilities Engineering and Expeditionary Warfare Center (EXWC), is demonstrating and evaluating a truck-mounted potable water distribution system to effectively perform hydrant flushing with no waste of potable water.

For scouring to be effective, a velocity of five cubic feet per second must be achieved. While conventional flushing typically produces a velocity of only one to three cubic feet per second, the high-velocity truck-mounted system chosen for the demonstration reaches the target five cubic foot velocity. Known as the Neutral Output Discharge Elimination System (NO-DES), the system has been used effectively in over 50 municipalities to date. It connects between two standard fire hydrants or between a fire hydrant and a fully open blow-off valve. The water from the hydrant is run through a filter system mounted on the truck to remove biofilm and clean out the line. The truck system also disinfects the water and returns it to the water system, resulting in zero water waste.

To demonstrate the NO-DES system, the drinking water system at the Navy Base Ventura County (NBVC) Port Hueneme base will be flushed. NBVC is a typical Navy installation where conventional hydrant flushing has shown to be ineffective. Water quality parameters will be collected before, during and after flushing to determine the system's effectiveness. Additionally, the base will be monitored for nitrification and chloramines for one year. At the end of this period, an economic analysis will be conducted to compare the costs of purchasing the equipment versus contracting for the flushing service as a better option to conventional hydrant flushing.

At the conclusion of the project, the NO-DES system will be demonstrated to selected potential users. The team will also prepare a video of the system in use, so that Navy public works directors can see the ease with which the system is set up and utilized.

Project 518: Impacts of Low Water Flows on Sewer Systems

Widespread mandated water conservation measures have resulted in reduced and concentrated flow through wastewater collection systems. While this is in itself an accomplishment, there is an unknown aspect of conservation that requires further study.

The NESDI program identified a need for the Navy to understand, assess, and address the impacts of water conservation measures on installation water and wastewater infrastructure. Because installation collection and distribution systems were designed for much higher flow rates, little is known about the impact of low

This wastewater treatment plant is designed for an average daily flow of 107,000 gallons per day. This image was taken during a time of low flow into the plant and shows the incoming sewage flowing through two bar screens, and finally into a Parshall flume where the flowmeter records the flowrate of the influent wastewater.
Tami Relph

wastewater flow on these systems. Potential problems could include increased corrosion in lines, elevated levels of hydrogen sulfide (a threat to sanitation workers in confined spaces), more frequent blockages, and increased concentrations of unhealthy contaminants.

This project, also headed by Tami Relph, was formed to determine whether such impacts are occurring, and if so, to recommend measures to overcome them.

The first phase of the project will include data collection from a significant portion of the Navy-operated systems and a select number of similar municipal systems, along

Outfall for the same wastewater treatment plant. The treated wastewater effluent discharges into a combined sewer line after chlorination.
Tami Relph

with detailed investigations of problem systems. The team will ask for data on flow rates, total suspended solids, nitrogen, Biological Oxygen Demand, and sulfur concentrations. These data are regularly collected for other purposes and therefore should be readily available. The project team will also collect data on Notices of Violation (NOV) as well as qualitative information from installation water program managers and the Water Media Field Team. This would include such data as increased odor, lift station blockages, higher hydraulic detention times, and increased grit loads after heavy rain due to low flow periods. Once these data are collected, they will be compiled into a spreadsheet to help identify problem issues that correlate with low flow conditions.

If no significant problems are identified, a final report will be prepared and the project will be terminated. If problems are found, the project team will gather additional information on the issues (such as additional laboratory analysis not normally performed by the Public Works staff) and will identify potential Best Management Practices (BMP) to address those issues. If an appropriate technology is identified that addresses a key problem with reduced flow rates in sewers or treatment plants, a limited duration demonstration may be recommended for future NESDI funding.

Aggressive water conservation strategies can reduce both facility and irrigation consumption rates.

Project 528: Impacts of Water Conservation Measures on Drinking Water Quality

Another project is addressing the need for the Navy to understand, assess, and address the impacts of water conservation measures on water infrastructure—specifically on drinking water systems.

Navy installations commonly struggle to maintain residual chlorine levels without exceeding the total THM standard at the far reaches of distribution systems. The levels of THMs and other byproducts of chlorination tend to increase with the amount of time water remains in a system, and when less water is used, this time period tends to lengthen.

To date, there has been no comprehensive trend analysis that demonstrates how water conservation efforts may contribute to the deterioration of drinking water quality. It is the goal of the project to assess a representative sample of drinking water systems to gain a better understanding of the impact of declining consumption on these systems.

There are a number of fundamental characteristics of drinking water supply systems common to many Navy facilities that may impact SDWA compliance:

- Low density land use planning strategies can lead to relatively long distribution runs between the supply system complex and the buildings it is designed to supply.
- Declining staffing levels can lead to reductions in total water demand.
- The capacity of aging water systems that were originally oversized to provide for fire flows can provide space for water to stagnate.
- The roughness of existing piping materials can allow for and even encourage development of biofilms (biomass).
- Aggressive water conservation strategies can reduce both facility and irrigation consumption rates.
- Regulatory standards that address water quality within the distribution system are becoming increasingly more rigorous.

Though this project will concentrate on the impacts of water conservation efforts, it will also identify operational, systemic or long-term policy changes that would minimize compliance problems. This will include an analysis of the current method for flushing and cleaning pipes discussed under the "Innovative Hydrant Flushing" project previously discussed. Additionally, the project team will assess trends in an attempt to more accurately evaluate future regulatory challenges that should be considered by drinking water system planners.

In the first phase of the program, the team, headed by Prakash Temkar of EXWC, will gather a representative

This project is studying the impact of declining consumption on drinking water systems.
Photographer's Mate 1st Class Bart A. Bauer

sample of drinking water system characteristics, examine NOVs, identify system problems, and define the current state of the practice. Representative case studies will be developed based on observed "real world" systems and problems.

Next, the project team will engage a group of Navy drinking water system experts to analyze specific systems and problems and recommend alternative strategies to address these problems. The team will then conduct a table top analysis of existing system designs including current water consumption rates and associated water conservation efforts.

Finally, the team will analyze specific recommended strategies based on anticipated benefit, cost, and potential risks. The team will also attempt to identify and evaluate operational BMPs, low-cost structural BMPs, and systemic (long-term) BMPs.

flow duration and magnitude), and contaminant loading to the receiving waters. The result is expensive data collection efforts that provide little information on the impact to the receiving waters. Additionally, when these limits are exceeded, the violations invariably require the implementation of BMPs that may not be effective or even appropriate.

This project, headed by Gunther Rosen of the Space and Naval Warfare Systems Center Pacific (SSC Pacific), will evaluate the effectiveness of using passive sampling devices (PSD) to assess the impacts of stormwater runoff and improve stormwater management. Passive sampling, as part of an integrated monitoring plan, shows great potential to provide the needed data.

Typically, stormwater monitoring consists of many components including:

Since the PSDs used in this project consistently sample over time, they automatically provide a time-integrated measure of contamination without extensive sampling and analysis costs. PSDs can provide meaningful data which are more representative of the potential for biological effects, because they will record time-varying exposure of contaminants released over time.

The project team will work with partners at Naval Base Kitsap (NBK), Naval Facilities Engineering Command (NAVFAC) Northwest, and the Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS&IMF) to integrate PSDs into their current stormwater monitoring efforts. Representative drainage basins will be selected that cover the range of land-use/land-cover and industrial activities present at NBK. Priority will be given to basins slated for installation of

PSDs can provide meaningful data which are more representative of the potential for biological effects.

Project 523: Stormwater Monitoring with Passive Sampling

A system for monitoring stormwater runoff is required by all Naval facilities as part of their National Pollutant Discharge Elimination System permit. Currently, stormwater monitoring is labor intensive, expensive, and not optimal for meeting regulatory requirements. Regulatory agencies are currently requiring an arbitrary monitoring schedule (monthly or seasonally) that ignores the driving forces within the watershed such as hydrology (e.g.,

- Identifying representative sampling locations.
- Establishing telemetry and data sensors for flow, conductivity/salinity, and turbidity.
- Installing rain gauge stations.
- Collecting manual grab and automated composite samples at specified locations).

However, these data are unable to provide information about pulsed (intermittent) inputs of contaminants into the receiving waters.

BMPs or other stormwater improvement projects so that before/after effectiveness can be evaluated.

This project will demonstrate two different types of passive samplers:

1. Diffusive Gradients in Thin Film (DGT) for metals
2. Polar Organic Chemical Integrative Samplers (POCIS) for contaminants including compounds that occur in human waste and wastewater

Over 300 chemicals have been calibrated for quantification by POCIS. This project will measure selected

A POCIS alongside a more traditional sampling method, oysters.
Gunther Rosen

A POCIS.
Gunther Rosen

organic marker chemicals found in human waste and wastewater including pharmaceuticals, hand sanitizers, fragrances, and others. Indicators of human waste to be sampled by POCIS will be selected based on site expectations to improve detectability near expected waste sources and to decrease false positives due to alternative sources that may be present on site (i.e. bird fecal material).

The DGTs will be deployed for multiple time points (days, weeks, months) to characterize the pulsed nature of metal exposure during storm events, and spatially to verify mixing of stormwater with the receiving environment.

Performance will be evaluated based on the cost and ability for the PSDs to provide meaningful data with which to quantify the effectiveness of BMPs and stormwater management programs.

This project will be conducted in coordination and collaboration with the Puget Sound Ecosystem Monitoring Program (PSEMP) Stormwater Work Group which is working with local, state and federal jurisdictions to develop a regional stormwater monitoring program, and the PSEMP Toxics Work Group which is assessing the impact of toxics on the Puget Sound ecosystem. The work will help expand the PSEMP's effort to include Navy facilities regulated by the U.S. Environmental Protection Agency (EPA) and address monitoring and BMPs for industrial sites.

The project will also leverage with a recent Environmental Security Technology Certification Program (ESTCP) project conducted at SSC Pacific. In this effort, DGTs are being integrated into a stormwater monitoring assessment strategy at Naval Base San Diego (ESTCP project #ER-201130) led by Gunther Rosen and a newer Strategic Environmental Research and Development Program (SERDP) project (#ER-2428), led by Danny Reible and SSC Pacific researchers, with a focus on stormwater contamination on sediments at Naval Base San Diego.

Successful completion of this project will make a major contribution to the watershed-based approach for stormwater management recommended by the National Research Council and assure that the Navy is adequately represented within the stakeholder groups.

Project 519: Analysis of the Long-Term Fate of Munitions Constituents on Terrestrial Sites

The Navy has approximately 325 terrestrial munition response sites where munitions or munitions constituents (MC) from unexploded ordnance and discarded military munitions are found and need to be remediated. While the fate and transport of the more common MCs such as TNT (2,4,6-trinitrotoluene) and RDX (cyclotrimethylene-trinitramine) in the environment are relatively well known, there are many associated degradation products and compounds (e.g., picramic acid) that form as the MCs degenerate. The fate, transport, and toxicity characteristics for these products are unclear, which hampers the development of viable risk assessments at impacted sites.

Discarded military munitions.

While site managers may be able to find some of the necessary information through literature searches, there is no one easy reference that captures this information in a concise format. This project was formed to identify, research, and summarize the current knowledge about the fate, transport, and toxicity characteristics of MC and associated degradation products found at terrestrial munition response sites. Information developed under previous SERDP and ESTCP efforts will be reviewed for applicability.

This project team, headed by Jim Austreng of EXWC, will develop a list of degradation compounds associated with each targeted MC. Factors such as fate (degradation behavior), transport (chemical and physical properties), and toxicity data for each compound will be covered as well as regulatory limits for the MC and degradation compounds, and a discussion of applicable remediation technologies. These data will be compiled into an Initiation Decision Report (IDR) that will identify gaps in the data as well as critical assessments of those gaps to aid in developing a remediation strategy.

The IDR will be available to Navy decision makers including Remedial Project Managers (RPM) via various channels including postings on websites and webinars. The report will enable them to survey the current state of knowledge about the fate, transport, and toxicity of MCs and to understand how specific targeted investments could enhance capabilities to respond to the associated risks. The summaries and assessments in the IDR may later be transferred to end users with similar responsibilities for other armed service branches.

The data in the IDR appendix can be used by RPMs, contractors, and opera-

Boat targets are often stockpiled until they can be inspected, taking up valuable space and interfering with day-to-day operations.

tional range personnel for addressing regulatory concerns about MCs and MC degradation products at terrestrial munition response sites and operational ranges.

Project 526: X-ray Inspection for Demilitarizing Boat Targets

The Navy has significantly increased training exercises that use small boat targets. Trainees fire tracer rounds at these targets, some of which become lodged in the targets themselves. When training is concluded, all targets are regarded as Material Potentially Presenting an Explosive Hazard (MPPEH) and must be certified as inert before disposal. This means the target must be free from all projectiles and be visually inspected by an Unexploded Ordnance Technician to certify it is Material Documented As Safe (MDAS) before it can be disposed of. Currently, this is a time-consuming process, and boat targets are often stockpiled until they can be inspected, taking up valuable space and interfering with day-to-day operations.

A boat target with mannequin.
NAVAIR Seaborne Targets


Small boat targets such as this one are often used in training.
NAVAIR Seaborne Targets

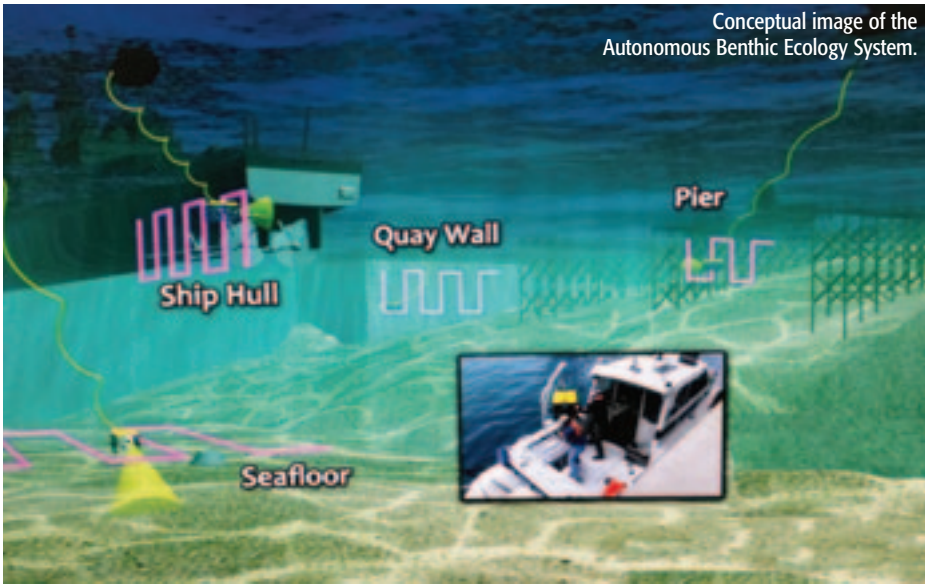
The Naval Air System Command (NAVAIR) Seaborne Targets program has an urgent need for a means to clear its targets as safe for repair and disposal following live fire operations.

To serve this need, Principal Investigator Joey Trotsky (from EXWC) and his team is demonstrating a handheld X-ray device that would allow inspectors to determine whether or not boat targets contain MPPEH. These machines have been recently developed for use in the dental and medical fields as well as for law enforcement to use on suspicious bags and vehicles. These hand held systems produce an easy-to-read image of the scanned object. If no projectile is found, the target can be immediately classified as MDAS. If MPPEH is found, minimal cutting and digging can be conducted to certify the material as safe for disposal.

Two different machines will be demonstrated at the NAVAIR Seaborne Targets Facility in Port Hueneme, California. Evaluation of the technology will include determining if the X-ray image will accurately show the locations of projectiles, the amount of time needed for a complete scan of the target, and the ease of use.

The new technology will be immediately available for use at the

Seaborne Targets Facility once it is successfully demonstrated. The ability for onsite personnel to classify a target as MPPEH-free will allow the prompt removal of the object to the Defense Utilization and Reissue Office, freeing up valuable storage space.



Conceptual image of the Autonomous Benthic Ecology System.

Project 521: Autonomous Benthic Ecology System

In order to comply with environmental directives, such as the National Environmental Policy Act (NEPA), the Navy needs the ability to conduct close, high-resolution monitoring of threatened and endangered species within coral reef communities and other benthic (seabed) ecosystems. This need became even more urgent in 2014 with the addition of 20 coral species to the Endangered Species List.

One way to effectively survey these areas is to create a photomosaic, or a collection of individual high-resolution images of each ecosystem. This technology was developed under an SERDP project, and demonstrated and validated under ESTCP funding.

The current approach to conducting photomosaicing surveys is to hire contract divers for months at a time to assess these areas in small sections or to assess small random areas and overestimate ecological metrics with statistical analyses. This is very costly and time consuming, and the data generated may not meet regulatory compliance under NEPA. Additionally, these surveys are currently conducted by various methods and entities, making data usability and comparability difficult.


Corals on Japanese Finger Pier, Apra Harbor, Guam.

Utilizing a remotely operated vehicle (ROV) to conduct underwater surveys would present a complete picture of the benthic community because these vehicles can travel into areas that are inaccessible, such as vertical structures, or dangerous for divers to access, such as areas with suspected unexploded ordnance.

This project, led by Cheryl Cooke of SSC Pacific, will develop and test an Automated Benthic Ecology System (ABES) for the purpose of conducting such surveys at sea ranges, vessel homeports and weapons test and evaluation centers. The system will leverage a previously developed sensor-based stabilized ROV which has been demonstrated for identification of waterborne improvised explosive devices. This ROV will be equipped with photomosaicing cameras as well as other sensors to capture parameters including pH, salinity, and temperature. The ABES will be able to traverse vertical structures such as piers and quay walls, and can safely survey areas with known or suspected unexploded ordnance. The vehicle will also prove useful in examining underwater surfaces for cracks or damage, including piers and ship's hulls.

In the first year of the project, the ROV will be equipped with the cameras and sensors. Next, the team will conduct tests to verify the vehicle's stability and agility, the accuracy of the results, and the kind of environmental disturbances the vehicle can handle. In year two, the team will test the integrated system in the ocean environment at a pier on San Clemente Island. This site offers a plethora of benthic environments to assess, including piers covered with fauna.

The final test will be a field study at Naval Air Station Key West. Two seawalls and a coral reef will be surveyed, and photomosaics of the pier wall will be made in the San Diego laboratory. This will determine whether or not the ABES is effective in extracting the data required by the Florida Keys National Marine Sanctuary, and to a greater extent, whether the system will be viable for compliance purposes at other sites.

A report will be generated documenting the suitability of the photomosaicing technology for compliance documentation. The report will contain the results of the field testing along with Graphical Information Systems maps for easy incorporation into environmental compliance documents of all types.

Project 522: Enhanced Monitored Natural Recovery for Sediment Remediation

Contaminated sediment in the Navy's harbors is anticipated to become a one billion dollar problem over time; more if potential natural resource damages are factored in. The most common current remediation techniques are dredging, capping and natural recovery—but all three methods have associated problems.

Dredging is very costly and may result in collateral impacts to aquatic biota, along with resuspension and resettling of contaminants. Capping, which involves covering submerged contaminated sediments with layers of sediment, gravel, and/or synthetic materials, is relatively less costly, but is not always possible in harbors with substantial ship traffic. Monitored natural recovery, while cost effective, is not always acceptable to regulators and public stakeholders, largely because it takes a large amount of time, and results can be unpredictable. Driven by a lack of suitable options and the increasingly apparent limitations of existing technologies over time, there is a need to develop more nuanced technologies and risk assessment methods.

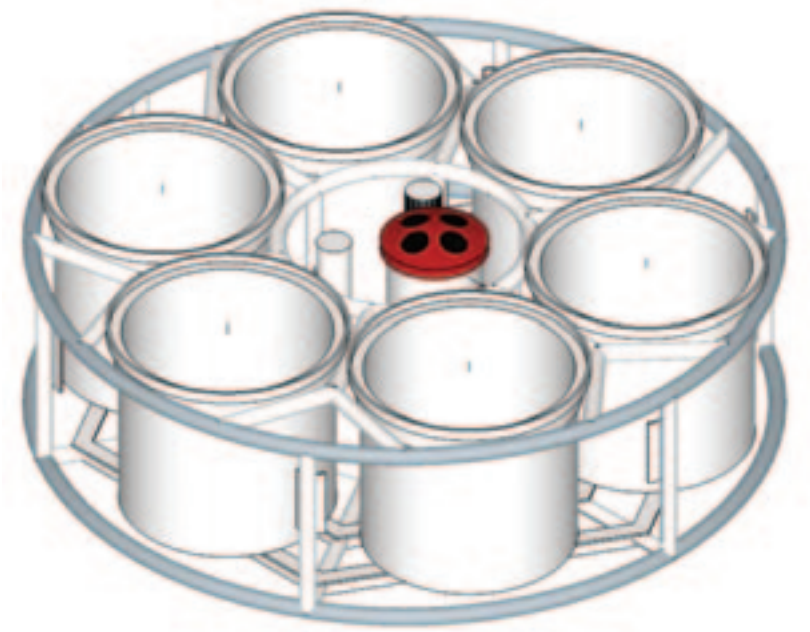
This project team plans to apply its field testing results at pilot scale at a Navy harbor in Puget Sound.
MC Seaman Apprentice William Blees

Cost effectiveness could also be significantly enhanced by integrating EMNR with opportunistic beneficial reuse of clean dredge sediments.

One of these methods is Enhanced Monitored Natural Recovery (EMNR). In this approach, thin caps (10-30 centimeters) of clean sediment are placed atop contaminated sediment to enhance ongoing natural recovery processes. In contrast to the thicker layers of sediment used in traditional isolation capping, thin caps used for EMNR are not intended to provide a complete seal over the contaminated sediment. Instead, they simulate an accelerated natural deposition of clean sediment, resulting in a surface layer of cleaner sediment and an immediate reduction in surface contaminant concentrations. This facilitates the reestablishment of benthic (bottom dwelling) organisms, and accelerates the processes of natural binding and physical isolation that would occur over time. True EMNR also lends itself well to beneficial reuse of clean dredge materials, and it is cost-effective. However there are few examples of true EMNR implementation in the U.S.

Previous EMNR efforts have been reviewed and summarized in an ESTCP project (#ER-201368) conducted by this project's Principal Investigator, Victoria Kirtay of SSC Pacific. These efforts utilized sand as the capping layer instead of local sediments or sediments with an appreciable organic content, and therefore have little or no binding capability.

The key focus of this project is the development of standardized procedures for applying EMNR using natural sediments at moderately contaminated Department of Defense (DoD) and Navy sites.



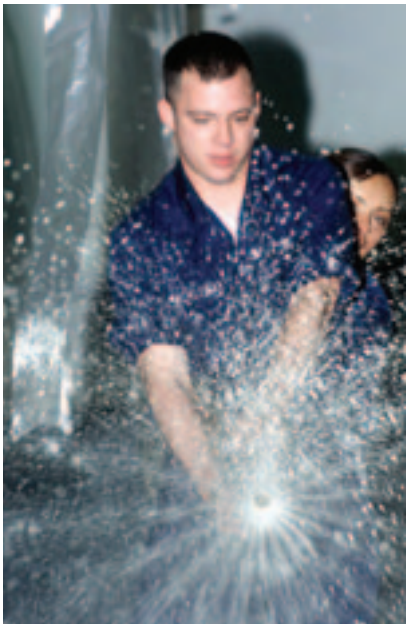
Sediments will be tested using a RARA array that is being developed for a SERDP project. This diagram shows an isometric view of the RARA with sediment trays and instruments installed.

Currently, the project team is defining key EMNR parameters and protocols, to ensure that the methodology can be replicated elsewhere. Then a range of natural sediments will be field tested using a Remedy And Recontamination Assessment (RARA) array that the project team is developing under ESTCP and SERDP funding. Next, the team plans to take the field testing results to application at pilot scale at a Puget Sound Navy site. This effort, leveraged with ESTCP funding, will include application of the protocols developed under this project, and potentially, integration with opportunistic beneficial reuse of clean dredged sediments. The scale of the demonstration will be tailored to the specific conditions and requirements of the chosen site, and constrained by the available funding. Performance and cost metrics will be captured for comparison to current capping methods and other sediment remedies.

EMNR technology, when implemented with natural sediments, promises to be both more successful and more cost effective than current approaches. Cost effectiveness could also be significantly enhanced by integrating EMNR with opportunistic beneficial reuse of clean dredge sediments.

Project 527: Structure-function Relationship of Perfluorochemicals from AFFF

Perfluorchemicals and polyfluorinated alkyl substances (PFAS) are chemicals that have been widely used for



Sailors test an AFFF hose during a Board of Inspection and Survey.
Photographer's Mate 3rd Class Robert M. Schalk

decades, both in consumer products and industrial processes. PFASs are unique in that they possess both hydrophobic (water-repelling) and oleophobic (oil-repelling) properties, making them especially useful in fighting fuel fires. The Navy and the other DoD services have used significant quantities of PFASs in the form of aqueous film-forming foams (AFFF) for fighting petroleum fires since the 1960s.

Despite their effectiveness, PFASs are defined as an emerging contaminant by the DoD. PFASs have been shown to cause developmental problems, have been implicated as immune-suppressants, endocrine disruptors, and some are classified as probable carcinogens. In addition, they are environmentally persistent due to their strong fluorine-carbon bond, are bioaccumulative, and have been detected in environmental samples long after a release was reported.

AFFFs are stockpiled and used in regular training exercises and emergency responses by fire departments throughout the DoD. AFFFs and their PFAS components represent one of the greatest emerging contaminant challenges facing the Navy's environmental restoration program, partly because the current understanding of their fate and transport in soil and groundwater is limited.

This project, headed by John Kornuc of EXWC, was formed to gather more information about these contaminants, and to develop a conceptual site model for Navy sites impacted by PFASs from various sources, especially AFFF.

PFASs are based on hydrocarbon chemicals where the hydrogen atoms in the carbon-hydrogen bond have been completely (perfluorinated) or partly (polyfluorinated) replaced by fluorine atoms. There are hundreds of PFASs, and analytical methods have only recently become available to accurately measure the major PFAS compounds of AFFF formulations used by the DoD. As a result, it has only recently become possible to conduct a full characterization of PFASs associated with AFFF use, and identify the various compounds and their behaviors/presence across a site.

The project team will begin by reviewing available data from 15 Navy and Base Realignment and Closure (BRAC) sites impacted by PFASs. The PFAS data will be closely inspected to identify preliminary trends and behavioral indicators. Factors such as nature of sources, distance of plume migration from its source, hydrogeology, and potential receptors will be compiled. This information will be combined with a literature review to develop preliminary indicators of fate and transport of the chemicals.

In the second phase of the project, three sites will be selected that have likely source zone areas and/or a plume that has migrated to potential surface water receptors. The authors will perform multi-level sampling at these sites, including sampling of surface sediment and benthic invertebrates. Utilizing this information, the project team will develop a decision tool with the ability to inform site managers and RPMs and enable them to make effective site management decisions when PFASs are present at their sites.

Project 525: Finding a Safe, Effective Alternative to Isocyanate Aircraft Coatings

For many years, polyurethane topcoat materials have been used for maintenance of military aircraft because of their superior abrasion-, stain-, and chemical-resistant properties. However, these products contain isocyanate compounds, which are regulated by the EPA as a hazardous air pollutant and a

AFFFs and their PFAS components represent one of the greatest emerging contaminant challenges facing the Navy's environmental restoration program.

Worker applying polyurethane coating to an F/A-18 aircraft.
Jennifer Nunez

The focus of this project is to validate mature products for both touch-up and full aircraft application.

hazardous waste. Because they pose a threat to human health, painters are required to wear personal protective equipment (PPE) and undergo medical monitoring when applying these formulations. Additionally, regulations require that the entire aircraft be roped off during spray applications of polyurethanes, thereby preventing concurrent work in nearby areas.

This project was formed to find a non-isocyanate formulation so that the Navy can minimize or eliminate the environmental hazards and health risks associated with currently used polyurethane products.

The Naval Research Laboratory (NRL) has recently developed two siloxane-based topcoats for Navy surface ships. Siloxane (also referred to as polysiloxane) polymers offer several advantages over organic-based isocyanate compounds, such as those used in polyurethane topcoats, due to the inherent chemistry of the materials. Siloxane materials have greater exterior durability (e.g., color stability) and thermal stability due to an increased resistance to UV/sunlight and heat. And because siloxane-based polymers are lower in viscosity, less solvent is needed to formulate a coating product. Siloxane is used in many consumer products and is relatively non-toxic and non-flammable.

The novel one-component and two-component siloxane products developed by the NRL are undergoing demonstration and qualification on two Navy surface ships and both are currently outperforming all qualified ship topside coatings. A concurrent ESTCP project is developing aircraft topcoats based on polymers used in the NRL coating formulations.

The focus of this project, led by Jennifer Nunez of the Fleet Readiness Center (FRC) Southeast, is to validate mature products for both touch-up (single component) and full aircraft application (two-component). Products will be tested for compatibility with existing aircraft finishing materials and non-chromate containing primer systems. Following compatibility testing, the coatings will be performance tested for adhesion, gloss, weatherability, flexibility, fluid resistance and heat resistance. Strippability

studies will also be performed to ensure siloxane systems can be fully integrated into FRC overhaul cycles. These tests will be performed at laboratory scale utilizing materials, equipment and facilities representative of industrial environments at NAVAIR FRCs. The criterion for success will be performance equal to or better than traditional polyurethane coatings qualified to military specifications MIL-PRF-81352 and MIL-PRF-85285. Due to the level of maturity, single component validation will occur first. Two-component systems will be validated within three years of project start.

Implementation of the new product(s) will occur through development of engineering documents to include use of siloxane coating for aircraft and components. Demonstration results will enable adoption of the technology throughout Level III FRCs through NAVAIR authorization and the development of Local Process Specifications that control processing requirements, materials utilized and quality conformance inspection. In addition, the siloxane coating technology will be added to the Authorized Use List at each paint shop in the desired application. FRC artisan training will also be provided based on the application optimization results.

Project 520: Quantification of PCB Paint Volatilization

The use and manufacture of paint containing polychlorinated biphenyls (PCB) has been prohibited for decades. Some Navy ships however, still have PCB-containing paint that was applied before use of this type of paint was prohibited. Because PCBs are known to become volatile (airborne) when heated, special measures must be taken when these ships arrive at the shipyard for welding and cutting operations. Current procedure requires the removal of PCB-containing paint up to a radius of 24 inches when performing work that has the potential to heat the steel in excess of 200 degrees Fahrenheit. However, there is a lack of data showing the quantity of specific PCB components volatilized as a function of temperature, and these controls may well be overly conservative.

This 24-inch removal requirement results in increases in time and cost to perform the required work, and generates a large volume of waste that needs to be safely disposed of. Additionally, the risk of safety issues for employees as well as injuries from chronic exposure to noise and vibration is elevated.

Currently, this problem is of great importance at PSNS&IMF due to the large volume of current and planned inactivation and recycling of Navy vessels. Other shipyards and maintenance facilities performing work on ships with legacy paint systems could also be impacted.

This project will investigate the volatilization rate of paint containing PCBs in order to generate a defensible, environmentally and fiscally responsible work process for the removal of paints containing these compounds.

The team, led by Patrick Morrow of the Naval Surface Warfare Center Carderock Division, will perform a thorough quantification study to

This NESDI project will investigate the volatilization rate of PCB-containing legacy paints on Navy ships.
MC Seaman Apprentice Robert Robbins

The Basics About the NESDI Program

THE NESDI PROGRAM seeks to provide solutions by demonstrating, validating and integrating innovative technologies, processes, materials, and filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Fleet readiness. The program accomplishes this mission through the evaluation of cost-effective technologies, processes, materials and knowledge that enhance environmental readiness of naval shore activities and ensure they can be integrated into weapons system acquisition programs.

The NESDI program is the Navy's environmental shoreside (6.4) Research, Development, Test and Evaluation program. The program is sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by NAVFAC out of the Naval Facilities Engineering and Expeditionary Warfare Center in Port Hueneme, California. The program is the Navy's complement to ESTCP which conducts demonstration and validation of technologies important to the tri-Services, EPA, and the Department of Energy.

For more information, visit the NESDI program web site at www.nesdi.navy.mil.

relate steel temperature to volatilization of PCBs within various paint systems. The study is based on standard EPA test methods, and will be carried out by accredited laboratory facilities. Samples of PCB-containing paint will be taken from a ship at PSNS&IMF and heated to a range of temperatures up to 400 degrees Fahrenheit in a controlled environment. The vapor phase during this heating process will be collected on low-volume polyurethane foam (PUF). This vapor phase testing will be conducted by scientists at the Naval Air Warfare Center China Lake, and the resulting PCB-bearing PUF samples will be sent to an outside laboratory competent in PCB extraction and analysis. The results of this analysis will show the total loading of PCBs resulting from exposure at different temperature levels. These data can then be correlated to available steel heating profiles developed at PSNS, enabling informed decision making, and the appropriate modification of current work processes.

The final product of this demonstration will be a work process that relates the paint removal requirements with paint type, thickness, and task to be completed. This process will be based on a statistically valid correlation of the loading of PCBs released into the atmosphere as a result of heating the paint to various temperatures corresponding with cutting and welding operations.

For More Information

One-page fact sheet summaries of all NESDI projects are available on the program's web site. No username or password is required to access them. Visit www.nesdi.navy.mil then select "Projects." You'll see a list of projects with the most recent efforts at the top of the list. Click on the "Fact Sheet" link in the "More Information" column for more details. Browse the "More Information" column to find additional links to project-related final reports, videos and *Currents* articles. ⚓

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